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Congestion Control in WSN using Cluster and Adaptive Load Balanced Routing Protocol

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Abstract: ***In a WSN power consumption and congestion are major bottlenecks. These two are inter-related too Power consumption causes several nodes to become dormant and thus increase congestion in the network. Also, congestion leads to abuse of network resources leading increased power consumption. By using adaptive load balancing technique, we reduce the problem of congestion in a network. We improved the traffic splitting protocol (TSP).The proposed method distributes the load in the network to all the nodes in the parallel direction such that no node has a congestion value above threshold. Simulation results have shown the algorithm to be efficient.***

Keywords: WSNs (Wireless Sensor Networks), CH (Cluster Head), LEACH (Low Energy Adaptive Clustering Protocol), ADC (Analog to Digital Converter), DAC (Digital to Analog Converter).

1. Introduction

A WSN contains different types of sensor nodes that are used to sense and transfer the information to the base station or the next neighbour node. By using such a configuration, sensor nodes in such WSNs have resource constraints like limited energy, low storage capacity, and weak computing ability [1].Recent technologies made it possible to minimise the cost and the bulkiness of the electronic devices. The network is capable of monitoring activities and phenomenon which cannot be monitored easily by human beings, such as site of nuclear accident, some chemical field monitoring or environment monitoring for longer period of time.[2] Micro sensor networks can contain hundreds or thousands of sensing nodes. It is desirable to make these nodes as cheap and energy efficient as possible and relay on their large numbers to obtain high quality results. The wide range of sensors is available such as humidity, movement, temperature, pressure, and lightening conditions are monitored [3]. Lower Power consumption restricts sensor to use the limited resources such as less low transmit power, memory requirement and less processing calculation. The aims is to provide better end-to-end delay, less number of dead nodes, a higher output, and overall lower power consumption compared to other protocols.

A state-of-the-art technology Wireless Sensor Networks (WSNs) is used to sense the data from all locations. Different parts of sensor nodes can be classified in six major units:

1. Communication Unit
2. Processing Unit
3. Sensing Unit
4. ADC/DAC Converters
5. Power Supply
6. Temporary Storage Unit

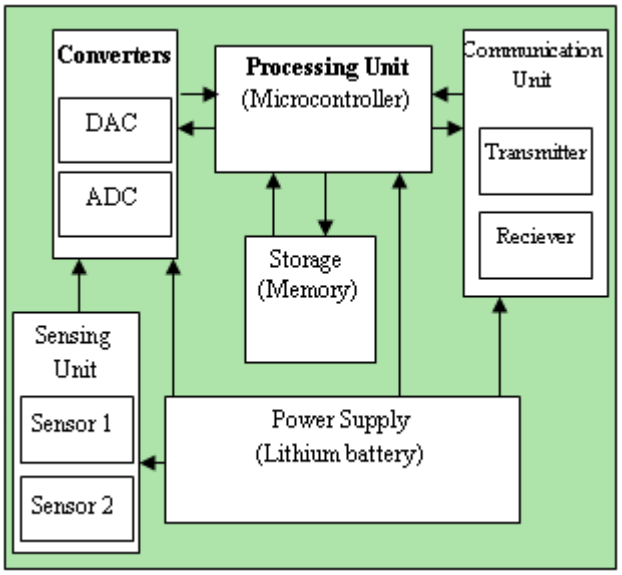

Figure 1: General Architecture

Figure 1.Shows general architecture of sensor nodes. The sensors in the sensing unit interact physically with the environment. The sensed data is send to the ADC/DAC converters. The micro-controller receives digital data and does the required processing by using the temporary memory.

The processed data are then transmitting to the transmitter of the communication unit for transmission towards the cluster head. On the other hand, the data from the Cluster Head is received by the receiver and then transferred to the processor for further processing. The power source used in sensor node can be a lithium battery. The two main parts where most of the power consumption occurs are:

1) The processing units and
2) The communication Unit.

The cluster head is either a mobile or fixed node, which has the capability to connect the sensor network to the internet where the user can access and process the data. Routing in WSNs is very essential due to the inherent traits that distinguish this network from other wireless networks or cellular networks. Limited memory and power are the parameters which affect the amount of data to process or store in an individual node. The architecture of typical WSN is shown in Figure 2.

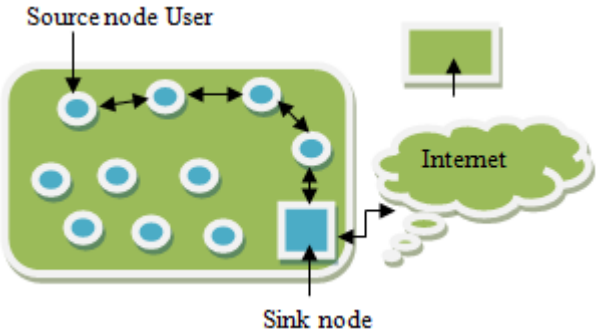

Figure 2: Wireless Sensor Network

The various areas including industry, commercial sector, or military fields are increasing its use rapidly all over the world. Healthcare becomes other area in industry and commercial sector where WSNs are being deployed. The deployed sensors help the hospitals and operators to monitor the patient's vital signs.

2. Related Work

Now we had three major schemes to discuss and implement. In WSN load can be balanced by using hierarchical clustering algorithm. Cluster formation and cluster election is very important for data gathering [4] Firstly Cluster head formation in cluster is formed, head is being chosen on basis of node with maximum battery life and shortest distance. Secondly TSP introduced four factor network size factors, network routing factor, network connectivity factor and network hopes factor [5]. Traffic splitting protocol in which the nodes are route on the basis of route assignment or load sharing method and thirdly ALB in which load of each node is being balanced so that each node carries same amount of load.

In the whole process the prime focus was on reducing the load on node which will in turn provide a good platform to improve upon number things as discuss in the objectives of thesis. ALB routing algorithm avoids the occurrence of link overload, was put forward &increased the network resource utilization rate and ensured data transmission reliable.

"Cluster and Traffic Distribution Protocol for Energy Consumption in Wireless Sensor Network" [6] .For load balancing in the network we improved the traffic splitting protocol (TSP). E-LEACH (Low energy adaptive clustering hierarchy) improves the performance of basic LEACH protocol whose aim is to elect the cluster-head on the basis of remnant energy of sensor node in WSN. Cluster head collects the data from all common node of their range E-LEACH has the same concept as of LEACH protocol. Difference between LEACH and E-LEACH is that in E-LEACH protocol includes additional parameter one is residue energy and second is consumed energy. There are two phases in E-LEACH as same in LEACH first phase is cluster set up phase and second is steady-phase. In cluster set up phase, cluster head select on the basis of round time as same LEACH protocol. The main improvement in cluster head selection algorithm is to avoid the lower energy residual energy node and elect the higher residual energy node. In second phase i.e. steady state phase each intermediated node sends the data during its own TDMA time slot. E-LEACH uses minimum spanning tree between cluster heads and sends the data to sink node. Traffic splitting protocol (TSP) consists of two methods. The first method is route assignment method and second is load sharing method. Route assignment method uses the information collected about each route to calculate weight for route. Second method i.e. load sharing method select particular route for individual data dynamically at real time. Also, it keeps the actual traffic allocated to each route relevant to the weight assigned to the route.

"Adaptive Load-Balanced Routing Algorithm" [7], ALB routing algorithm is based on minimum interference and cross-layer design principle is proposed. The least interference path algorithm principle is introduced briefly, and the implementation of adaptive load-balanced routing algorithm is to elaborate in detail. The good interaction of the information between the layers based on cross-layer optimization, this improved the least interference path algorithm and presented a new routing algorithm named adaptive load-balanced routing algorithm which could effectively avoid the occurrence of link overload, was put forward. The algorithm could realize the prediction of network congestion and TCP can adjust the congestion window size self-adaptive according to the real-time status of link. The simulation results show that packet loss rate had been greatly improved and throughput rate had got a large scale enhancement. It not only avoided the occurrence of link overload phenomenon, but also increased the network resource utilization rate and ensured data transmission reliable.

"Improved clustering protocol for energy efficiency algorithms in wireless sensor networks", [8].This algorithm is used for energy efficient routing based on a cluster head selection. To extend the lifetime of networks and it improves node energy efficiency, balances energy consumption of all sensor nodes, increases dependability of data transmission and remits network lifetime in comparison of existing clustering protocol. The proposed algorithm having a two layer of cluster formation between the nodes and Base station like LEACH, it consists of two layers of clusters establishment. On the first layer Cluster Heads are formed where the member nodes transmit the data to their respective Cluster Head and CH aggregate the received data. Once again the second layer super Cluster Heads are formed. After the formation of Super Cluster Head (SCH), the CHs look for the nearest SCHs by computing the distance between the CH data to respective Super Cluster Head (SCH) in the similar like a LEACH.

The Super Cluster Head (SCH) received data from their Closest Cluster Head, aggregate all received data,

transformed them into a compressed data and send to the base station (BS). The number of Cluster Heads and S-CHs are initially decided by using a predetermined fractional value. In SCH LEACH, Minimize the overall communication distance between the nodes and Base Stations. The routing protocols LEACH, M-LEACH and Proposed algorithm have simulated in MATLAB. The average distance and average energy dissipation are calculated and compare the average energy and distance.

3. Proposed Algorithm

A. Design Consideration

Table1: Initial parameter

S. No.	*Name*	*Value*
1	Network Area	400*400 sq. Units
2	No. Of Nodes	50
3	Delay between subsequent Packet	0.2 unit
4	Packet Size	5 bit
5	Initial energy	500mJ

B. Description of Proposed Algorithm

Here in designing algorithm adaptive load balancing technique and traffic splitting protocol works with E-LEACH protocol.

Step I Cluster head formation: In clustering, each node takes part in cluster head formation. The process of cluster head formation on basis of battery consumption left. The battery having more power left is chosen to be cluster head. This whole processes takes place in following sequence:

1) First layer Cluster Heads are formed where the member nodes transmit the data to their respective Cluster Head and CH aggregate the received data.
2) Second layer super Cluster Heads are formed.
3) After the formation of Super Cluster Head (SCH), the CHs look for the nearest SCHs by computing the distance between the CH data to respective Super Cluster Head (SCH) in the similar like a LEACH.
4) The Super Cluster Head (SCH) received data from their Closest Cluster Head, aggregate all received data, transformed them into a compressed data and send to the base station (BS).
5) The number of Cluster Heads and S-CHs are initially decided by using a predetermined fractional value.

Step II Traffic Splitting Protocol: By enhancing the traffic splitting protocol (TSP) load balancing in the network easily. This improved traffic splitting protocol (TSP) in steady state phase uses each intermediated node sends the data during its own TDMA time slot. TSP consists of two methods.

1) Route assignment method uses the information collected about each route to calculate weight for route. In this method we select the path to be followed for sending packets from sender to receiver node. This selection is on basis of routing table we have in our record. We find shortest distance path from routing table.
2) Load sharing method select particular route for individual data dynamically at real time. This load sharing is done to reduce the load of each node sending data to other node. This load sharing ensures best use of available power in nodes.

Step III ALB: This routing algorithm avoids the occurrence of link overload, was put forward & increased the network resource utilization rate and ensured data transmission reliable. E-LEACH (Low energy adaptive clustering hierarchy) protocol includes additional parameter one is residue energy and second is consumed energy & two phases first phase is cluster set up phase and second is steady-phase. In cluster set up phase, cluster head avoid the lower residual energy node and select higher residual energy node.

4. Pseudo Code

Step 1: let load at 4 paths be L1, L2, L3 & L4.
Step 2: Start for loop path 1 >=4.
Step 3: if (L1 > T) \\ T is the load threshold.
Step 4: find difference in load D= L1 - T;
Step 5: if (L2 ' < T).
Step 6: put extra load to this path L2 = L2 ' + D; \\ L2 & L2 ' are the current and previous loads.
Step 7: end if condition;
Step 8: if (L3 ' < T).
Step 9: put extra load to this path L3 = L3 ' + D; \\ L3 & L3 ' are the current and previous loads.
Step 10: end if condition;
Step 11: if (L4 ' < T).
Step 12: put extra load to this path L4 = L4 ' + D; \\ L4 & L4 ' are the current and previous loads.
Step 13: end if condition;
Step 14: end if condition;
REPEAT THE STEPS 2 TO 14 FOR L2, L3 & L4 also.

5. Simulation Result

To get the simulation results MATLAB tool is used. As mentioned earlier, E-LEACH using ALB works in rounds. For our experiments the total number of rounds used is 20. E-Leach with TSP helps in proper routing of different nodes according to two different methods. First is route assignment method in which nodes are send according to routing weight of different paths, Second is Load sharing method in which routing of nodes is done in such a way that each nodes share same load. While in the case of ALB routing algorithm avoid the occurrence of link overload, was put forward & increased the network resource utilization rate and ensured data transmission reliable .E-LEACH (Low energy adaptive clustering hierarchy) protocol includes additional parameter one is residue energy and second is consumed energy & two phases first phase is cluster set up phase and second is steady phase In set up phase, all the nodes are being balanced according to the load. While in steady phase all the nodes transmit equal amount of information from source to sink. Simulations of E-LEACH using ALB in comparison with E-LEACH in which only one path is considered and E-LEACH using TSP in which paths are four but unbalanced performed to observe the average load, power left, power consumption, end-to-end delay, average jitter and overall PDR or throughput.

A. Average Load: Figure 3 shown that the total no. of average load in E-LEACH using TSP is higher than the total no. of average load in E-LEACH using ALB also shows average load of E-LEACH using TSP (Traffic splitting protocol) & ALB (Adaptive load balancing).

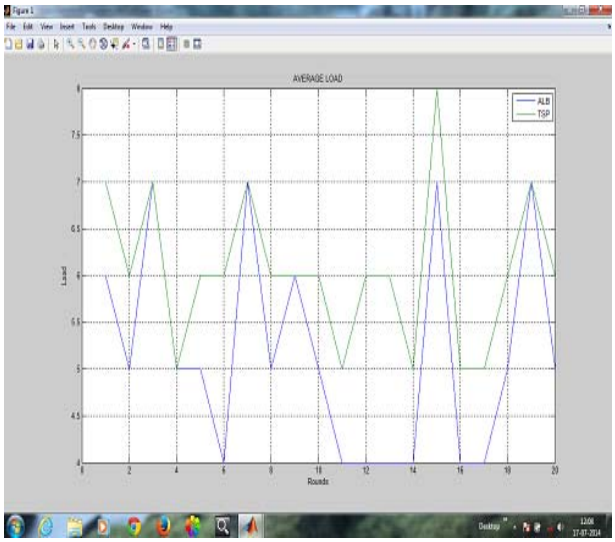

Figure 3: Total number of average load in E-LEACH routing protocol using TSP & ALB.

As ALB algorithm adaptively balanced the load in the network & gives better results in terms of network lifetime, end-to-end delay and throughput.

B. Power Left Comparison: Figure 4 shows the total number of power left after each round of E-LEACH, E-LEACH using TSP (Traffic splitting protocol) & ALB (Adaptive load balancing). The E-LEACH using ALB protocol has the overall network life of 10 rounds, while E-LEACH and E-LEACH using TSP has network life of 7 and 9 rounds respectively.

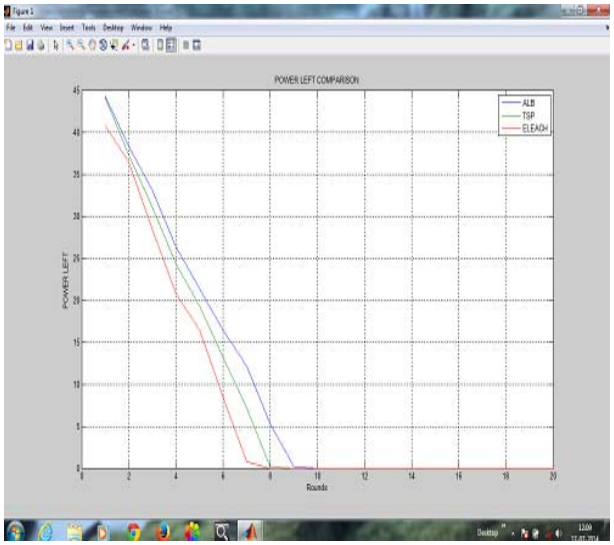

Figure 4: Total number of power left in each round in E-LEACH, TSP & ALB

This shows that our proposed protocol is about 30% and 10% better network lifetime than E-LEACH and E-LEACH using TSP respectively.

C. Power Consumption Comparison: Figure 5 shows the energy consumption comparison of E- LEACH having one path, E -LEACH using TSP having four paths but unbalanced unlike ALB and E-LEACH using ALB.

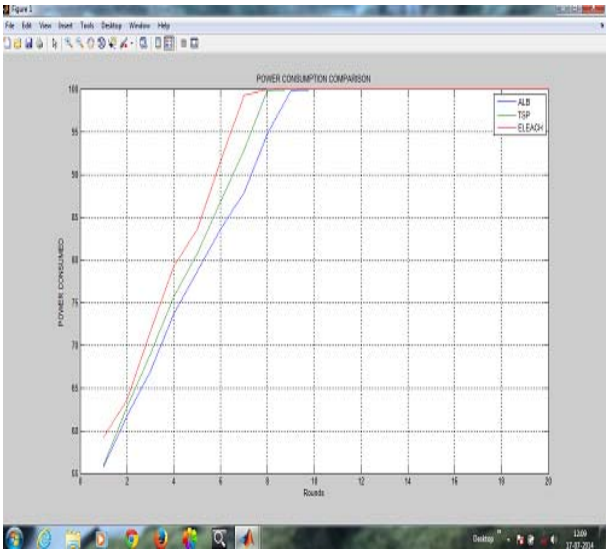

Figure 5: Total number of power consumed in each round in E-LEACH, TSP & ALB.

The E-LEACH using ALB protocol reaches the threshold level of 100 joules in 10 rounds, while E-LEACH and E-LEACH using TSP consumes 100 joules of energy in 7 and 9 rounds respectively. This shows that our proposed protocol is about 30% and 10% better in energy consumption than E-LEACH and E-LEACH using TSP respectively.

D. Throughput (Bits/s): The ratio of total data received by a receiver from a sender for a time the last packet received by receiver measures in bit/sec and byte/sec. It can be expressed mathematically as;
Throughput (bit/sec) = Number of delivered packet * Packet size * 8 *Total duration of simulation.

The throughput of the protocols can be defined as percentage of the packets received by the destination among the packets sent by the source. The throughput is measured in bps (bits per second). The number of bps must be high for a better system performance.

Figure 6 shows that throughput of E-LEACH using ALB is significantly greater as compared to E-LEACH and E-LEACH using TSP. Graph shows that the throughput of E-LEACH using ALB is more than the other two protocols because of adaptively load balancing in clustering and provide congestion free network.

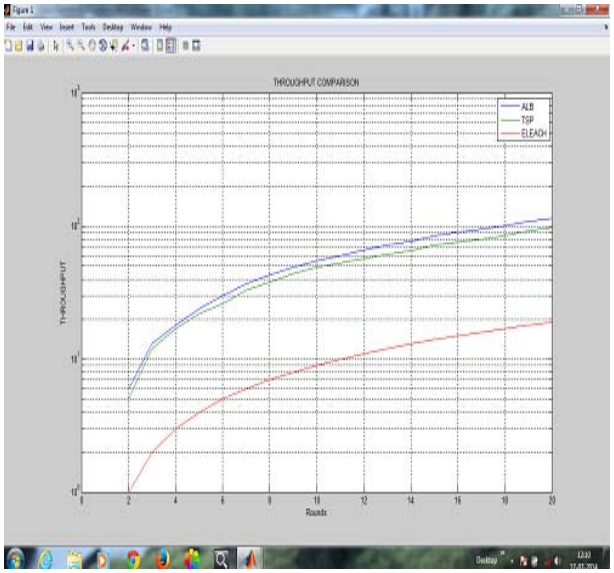

Figure 6: Comparison of E-LEACH, TSP & ALB Protocols with respect to Throughput.

Thus, it proves that E-LEACH using ALB has higher throughput as compared to E-LEACH and E-LEACH using TSP.

E. Average End-To-End Delay: Average End-to End delay is difference between the time at which the first packet was send by transmitter node and time at which that packet was being received by destination node. The Average of End-to-End delay in case of E-LEACH is maxim in case of ALB it is minimum and average in the case of TSP, as shown in figure ALB gives better result than the E-LEACH & TSP.

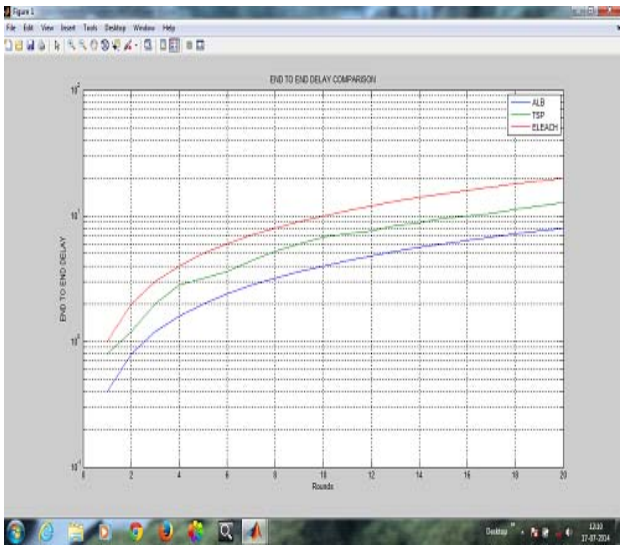

Figure 7: Comparison of E-LEACH, TSP & ALB Protocols with respect to Average End-to-end delay.

F. AVERAGE JITTER(s): Average Jitter is the time gap between the different packets arriving at the destination node. This may caused by network congestion, drift in time, different routing paths, and many more.

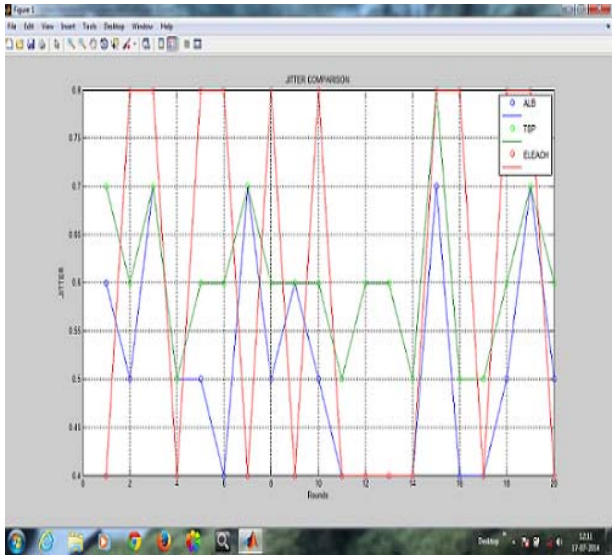

Figure 8: Comparison of E-LEACH, TSP & ALB Protocols with respect to Average jitter.

Average Jitter is maximum for E-LEACH, minimum for ALB and average in the case of TSP, as a network size of 100 nodes it is found that the jitter in the case of ALB gives better result than the E-LEACH & TSP.

6. Conclusion

Sensors are required to route packets as well as transmit the data to the base station. If more of these operations are performed the sensor battery life decays drastically. By using the proper communication protocol, the control of congestion and unnecessary data transmission or reception can help in better management of battery life. By considering the influencing factors such as congestion, energy awareness, scalability and latency, the purpose of this research is to find a congestion free energy efficient routing protocol for Wireless Sensor Networks.

7. Future Scope

In future the use of wireless technology will more prominent so reducing the consumptions of power of the devices involved in transmission/reception is the main requirement of the future. The investment of time and technology is being made to solve this problem and methodologies like LEACH, E-LEACH, ALB, etc. That helps in the cause of making wireless technologies more efficient.

References

[1] I.Akilildiz, Sankarasubramanian, E. Cayirci, “Survey on sensor networks,” pp. 102-1145, IEEE 2002.
[2] NaumanIsar and Irfan Awanet et al”Multihop Clustering Algorithm Load Balancing In Wireless Sensor Network”.
[3] Wendi Rabiner Heinzelman, Anantha Chanderakasan, and Balakrishnan et al ”Energy-Efficient Communication Protocols For Wireless Micro sensor Networks ”.
[4] Tejal D. Irkhede and B. N. Mahajan et al.“Load Balancing Technique for Distributed and Specialized Nodes using Multipath Approach in Wireless Sensor Network”.

[5] Mohomed Ebada, "Traffic Routing Protocol for multipath routing in WSN", 2011 IEEE
[6] Irkhede Tejal, ME (WCC) Project Student and Jaini Prachi et al. "Cluster and Traffic Distribution Protocol for Energy Consumption in Wireless Sensor Network".
[7] Xiao Guo Ye, Kang MengLv, RuChuan Wang and Li Juan Sun, et al "Adaptive Load-Balanced Routing Algorithm".
[8] Kalaiselvi K. and Suresh G.R., et al "Improved Clustering Protocol for Energy Efficiency Algorithms In Wireless Sensor Network".